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$$\begin{vmatrix} a & \beta & \gamma \\ \gamma & a & \beta \\ \beta & \gamma & a \end{vmatrix} = \begin{vmatrix} a & b & c \\ c & a & b \\ b & c & a \end{vmatrix} \cdot \begin{vmatrix} x & y & z \\ z & x & y \\ y & z & x \end{vmatrix}.$$

Also solved by J. B. Faught, G. B. M. Zerr, G. W. Greenwood, Grace M. Barels, J. O. Mahoney, F. D. Posey, F. O. Whitlock, J. Scheffer.

** Dr. L. E. Dickson points out that a similar theorem holds for any determinant whose matrix is the body of a multiplication-table of a finite group.

GEOMETRY.

251. Proposed by R. D. CARMICHAEL, Hartselle, Ala.

Represent the vertices of any regular polygon by the consecutive numbers 1, 2, ..., p , ..., q , ..., r , ..., n . To find the sides and area of the triangle formed by joining p , q , and r .

Solution by G. W. GREENWOOD, M. A. (Oxon), Lebanon, Ill., and A. H. HOLMES, Brunswick, Me.

The central angles subtended by the chords (pq) and (qr) are respectively,

$$2(q-p)\frac{\pi}{n} \text{ and } 2(r-q)\frac{\pi}{n}.$$

The angle pqr is found to be $\pi - (r-p)\frac{\pi}{n}$. Hence the required area is

$$\frac{1}{2} \cdot pq \cdot qr \cdot \sin \angle pqr = 2a^2 \sin(q-p)\frac{\pi}{n} \cdot \sin(r-q)\frac{\pi}{n} \cdot \sin(r-p)\frac{\pi}{n},$$

where a is the radius of the circum-circle of the polygon.

252. Proposed by FREDERICK R. HONEY, Ph. B., Trinity College, Hartford, Conn.

Two plane mirrors form an angle which is less than 45° . Any two points are assumed within this angle in a plane perpendicular to the intersection of the mirrors. A ray of light passes through one point, and after being reflected twice at each mirror, it passes through the second point. Find the path of the ray.

Solution by R. A. WELLS, Westminster College, Fulton, Mo.; THEODORE LINQUIST, Wahpeton, N. D.; and the PROPOSER.

Let oa and ob represent the mirrors; and P and Q the assumed points. Draw oc , od , and oe , making each of the angles boc , cod , and doe equal to aob . Draw Pf perpendicular to oa . Make $of = of$; and draw fP' perpendicular to oe and equal to Pf . Draw QP' , intersecting ob at l , oc at k' , od at h' , and oe at g' . Make $og = og'$; $oh = oh'$; $ok = ok'$. Join Pg , gh , hk , and kl . $PghklQ$ is the path of the ray.

